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(OPERATIONS RESEARCH)

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OFFICE OF THE UNDER SECRETARY
WASHINGTON, D.C. 20310-0102

1 June 1997

SFUS-MIS

MEMORANDUM FOR SEE DISTRIBUTION LIST

SUBJECT: Army Study Highlights, Volume XVII

The Army Study Highlights is published annually to acknowledge outstanding efforts of individual and group analysts and to encourage continued excellence in the Army analysis community. The visibility provided by this publication is an opportunity for others to take advantage of examples of good work. A panel of experienced senior level analysts selected eleven studies for this volume. Those studies were quite varied which provided an interesting mix.

The selected studies represent examples of efforts that are of significance to the Army's missions and goals and are indicative of the broader contribution of analysis to today's Army. Selections were based on an assessment of the principal findings, main assumptions, principal limitations, scope, objectives and approach, and the impact and utility of the study to the Army. Examples of quality analysis have proven to be beneficial to the younger analysts entering the analysis community as well as a refresher for the more experienced analysts. I urge you to make the widest possible distribution of this publication.

This volume also serves to recognize recipients of the 1996 Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis. Two awards were presented this past year, one for the best individual authored paper and one for the best group authored paper. Each year these awards are presented at the Army Operations Research Symposium, Fort Lee, VA. We are proud to include excerpts of this outstanding work in the Army Study Highlights.

We welcome your suggestions. Comments and requests for additional copies of this publication should be directed to Mr. William Barr, of this agency, (DSN) 327-3376 / (C) 703/607-3376.

JOANN H. LANGSTON, Director
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Office of the Deputy Under Secretary
of the Army (Operations Research)

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Director, US Army TRADOC Analysis Command, ATTN: ATRC-ZD, Fort Leavenworth, KS 66027-2345

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Director, Strategic Studies Institute, ATTN: AWCI, Carlisle Barracks, PA 17013

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Chief of Public Affairs, ATTN: SAPA-ZA, Pentagon, Room 2E636

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Chief of Chaplains, ATTN: DACH-ZA, Pentagon, Room 2E444

The Inspector General, ATTN: SAIG-ZA, Pentagon, Room 1E736

The Surgeon General, ATTN: DASG-ZA, 5109 Leesburg Pike, Room 671, Falls Church, VA 22041-3158

The Judge Advocate General, ATTN: DAJA-ZA, Pentagon, Room 2E444

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Office of the Director (PA&E), ATTN: ODPA&E, Pentagon, Room 3E835

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STUDY GIST

AMXSY-LM

SUBJECT: Technical and Economic Analysis Comparing Alternative Chemical Demilitarization Technologies to the Baseline, Special Publication 75, July 1996

PRINCIPAL FINDINGS: The Alternative Technologies (AT) are comparable to the baseline incineration process and have comparable, and in some cases, significantly lower life cycle costs. None of the ATs are as technically mature as the baseline process. No technical impediments were identified to prevent any AT from having the potential to destroy bulk chemical agent stockpiles at Aberdeen Proving Ground (APG) and Newport Chemical Depot (NECD). As of 31 May 1996 the Neutralization/Biodegradation process is the most technically mature process for APG while the M4 Catalytic Extraction process is the most mature AT for NECD.

MAIN ASSUMPTIONS: Technology specific proposals assume that the offeror will conduct operations at either or both APG and NECD. Cost data contained in the proposals was considered to be a valid starting point for the analysis. Specific assumptions on schedule task durations, e.g., permit approval and closure, were incorporated into each technology schedule.

PRINCIPAL LIMITATIONS: This analysis was conducted using information obtained through May 1996. Significant changes to a technology program occurring after this date which may impact cost and schedule are not included in the analysis.

SCOPE OF THE EFFORT: The technical analysis used a risk assessment approach to evaluate each technology by site. Areas of analysis included: process operability, process capability, process safety, environmental and regulatory compliance, and schedule. The economic analysis compared the life cycle costs of each technology by site. In addition, a cost risk assessment was conducted as part of the economic analysis.

OBJECTIVE: The study objective was to conduct a technical and economic analysis comparing chemical demilitarization technologies being considered as possible alternatives to the baseline incineration process at the bulk-only storage sites at APG and NECD.

BASIC APPROACH: To conduct the analysis AMSAA used information gathered from operational/test data, site visits, concept design packages, cost documents and proposals, and meetings with the Product Manager for Alternate Technologies and Approaches (PM ATA), state regulators and contractor personnel. Risk definitions were based on standard Army definitions tailored to the chem demil process. The risk assessment approach was used due to the varying amounts of technical information and design maturity, for both specific chem demil operations and for related commercial operations, available for each technology. The objective of the risk assessment was to incorporate technical information, both chem demil specific and related commercial, into the cost and schedule

risk assessment. Process operability was considered to be the main measure of technical maturity and impacted the risk ratings in all other areas of the technical analysis. The economic analysis used cost related information to determine the specific costs applicable to each chemical destruction method by location. Cost and schedule inputs were used in a cost model developed to assist in estimating life cycle costs by site and technology. Main cost categories included facility design, equipment, environmental regulations, construction, systemization and training, operation, and facility closure upon mission completion. A cost risk assessment was conducted to quantify the uncertainty associated with the cost drivers and changes in schedule. Results of the risk assessment were then used in sensitivity analyses to develop a range of potential costs by element and by alternative.

REASON FOR PERFORMING THE STUDY OR ANALYSIS: This analysis was performed in response to a tasker from the PM ATA.

IMPACT OF THE STUDY: Analytical results were provided to the PM ATA for use in the bulk chemical agent destruction technology selection process for APG and NECD.

SPONSOR: Product Manager for Alternative Technologies and Approaches

PRINCIPAL INVESTIGATOR: Mr. Carl Eissner, Mr. John Conolly and Mr. Robert Miele

NAME/ADDRESS/PHONE NUMBER WHERE COMMENTS & QUESTIONS CAN BE SENT:

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DEFENSE TECHNICAL INFORMATION CENTER (DTIC) ACCESSION NUMBER OF FINAL REPORT: Report available by contacting the Product Manager for Alternative Technologies and Approaches, DSN 584-1438.

OTHER THAN THE STUDY SPONSOR, WHO COULD BENEFIT FROM THIS STUDY/INFORMATION? Organizations involved in analysis of technologies suitable for chemical agent destruction.

ARROYO CENTER

1. Study Title. Analytic Support to the Defense Science Board: Tactics and Technology for 21st Century Military Superiority

2. Study Purpose. Provide simulation support to the Defense Science Board 1996 Summer Study.

3. Critical Issue Addressed. To what extent can advanced technologies enhance and, thus, *enable* small forces (Brigade and below) to fight and survive against much larger forces?

4. Objective. The study provides quantitatively supported insights into the effectiveness of advanced small force concepts. Specifically, it explores the value of advanced reconnaissance, surveillance, and target acquisition (RSTA) and command and control (C2) systems coupled with long-range remote fires to support small forces.

5. Principal Findings. Advanced RSTA, C2, and remote fires can provide considerable capability to small forces. However, contrary to conventional wisdom, we found several limitations in the small force concepts, even those with extensive materiel improvements. For example, multiple-tiers of advanced RSTA systems (including distributed ground-based sensors and high-altitude endurance unmanned aerial vehicles) had limitations in timeliness, accuracy, or completeness that resulted in an incomplete picture of the battlefield. Inherent delays associated with remote fires (including C2 times and time of flight) often required a smart munition to be launched before a previous engagement finished, which greatly reduced round efficiency. Even with ideal RSTA and streamlined C2 processes, remote fires that use terminal sensors and processing require tradeoffs between the ability to find targets and the ability to engage unique target, and an increased volume of fire exacerbates this problem. As a result of the combined limitations, small forces must have some organic capability to engage targets in order to accomplish early entry missions successfully and efficiently.

6. Impact/Utility to the Army. New small force concepts are attractive for many reasons, but they have numerous shortcomings that have yet to be resolved--even in theory. This study provides insights into some possible shortcomings, and, in many cases, these run counter to current thinking. More importantly, though, it underscores the need to think these concepts through and to evaluate them completely.

7. Main Assumptions. We assumed perfect C2 connectivity, and we also assumed different RSTA and weapon system technologies, although discretely simulated functioned as planned.

8. Principal Limitations. Given the short time available for the study, we examined small force effectiveness over a relatively narrow set of possible circumstances and missions. A larger set of possible situations might uncover a greater number of new issues and challenges.

9. Scope. Small force concepts in this research were examined within a single scenario (based on TRAC HRS 33.7), in an early entry defense against attacking armor. Within this context, the utility of different levels of RSTA, length of C2 times, and types of remote fires were examined parametrically to support a small, brigade-sized ground force.

10. Approach. We employed a Janus-based ensemble of models to examine small force concepts. This approach provided the means for high-resolution, force-on-force combat simulation, where the effect of each component of the small force concept (advanced RSTA, fast C2, and remote fires) could be explored and assessed.

11. Study Sponsor. Office of the Secretary of the Army for Research, Development, and Acquisition; Deputy Secretary of the Army for Research and Technology.

12. Performing Organization and Principal Authors.

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Authors: John Matsumura (POC, 310/393-0411 Ext. 6219),
Randall Steeb, Tom Herbert, Mark Lees, Scot Eisenhard, Angela Stich

13. Literature Search. Not applicable.

14. DTIC Accession Number. ADA323925

15. Start and Completion Dates. July 1996 - August 1996.

ARROYO CENTER

1. Study Title. Post-Mobilization Training Resource Requirements: Army National Guard Heavy Enhanced Brigades.

2. Study Purpose. This study analyzes the resources the Army needs to carry out post-mobilization training of enhanced heavy National Guard brigades before they could deploy to a wartime theater.

3. Critical Issues Addressed. Given recent force reductions, in a future wartime situation it is unlikely that Active Component divisions will be available to support post-mobilization training of reserve component combat forces. At issue, then, is how much support would be needed for such training, where it would come from, and the implications for training quality.

4. Objectives. The study identifies the training resources needed to execute the model, including installations, garrison support, ranges, training areas, trainers, Opposing Force personnel, and training support personnel. As a necessary by-product, it also lays out a detailed model of the steps, training events, and time needed after mobilization to prepare Reserve Component heavy brigades for deployment.

5. Principal Findings. The study concludes that under current plans the Army will have sufficient training personnel and other resources to run three brigade training sites simultaneously, assuming that the Reserve Components can provide an Opposing Force to augment the 11th ACR from Fort Irwin, training support personnel, and garrison support for collective training sites. This would produce as many as three trained brigades as early as 102 days after mobilization. The resource bill, however, would be substantial, requiring almost 22,000 people from the Active and Reserve Components (including, for example, a skilled OPFOR that must come from the National Guard). Furthermore, there are risks that the actual training might proceed more slowly. For example, some brigades may not be as ready as the model assumes, and the intensive pace of post-mobilization training would require logistics resources such as spare parts and ammunition at a time when other, higher-priority units are also preparing for deployment.

6. Utility to the Army. The results provide the Army great detail about the post-mobilization requirement—down to specific training events, installations, and individual trainers by grade and MOS—and they establish that the Army has the resources to train three brigades at a time, in parallel. However, they also highlight actions needed to ensure that resources will be available when and where needed. For example, some actions must occur in peacetime, and presently no one has the responsibility or assets to accomplish them.

7. Main Assumptions. (a) The brigade must be trained to enter combat upon arrival in theater, and capable of carrying out three missions (movement to contact, deliberate attack, and area defense). (b) The brigade's pre-mobilization training matches or exceeds that of the better brigades in recent Annual Training periods (emphasizing platoon-level maneuver and gunnery). (c) All personnel will be qualified and stabilized in their duty assignment by M+18. (d) Equipment will need minimal maintenance before the start of training, and spare parts and ammunition will be available to support a high OPTEMPO at the training site. (e) Before the unit's arrival, the Army will have completed the myriad of tasks to support an intensive training schedule (e.g., organization, lane preparation, and Opposing Force training).

8. Principal Limitations. The study assumes that the above conditions will be met, in the context of the current reserve training strategy and the current resourcing plans for active support to the reserve components. If the conditions are not met or resources are not available, the training time would take longer or training quality would be at risk.

9. Scope. The study concerns heavy brigades, not light or other types of forces. It also focuses on a combat mission. The brigades could be assigned a range of different missions, some of which are less demanding and would require less training.

10. Approach. The study designed a training model for all units in an enhanced heavy brigade, showing each training event and emphasizing parallel training to minimize elapsed time. The model flows units through section- through brigade-level training, based on active and reserve component experience and training activities spelled out in Army training publications. We then determined the support required for each event (e.g., trainers, training support personnel, ranges, and maneuver areas), ensuring that no conflicts occurred at a given site. Finally, we identified feasible training sites and determined appropriate sources (and shortfalls) for each resource required.

11. Study sponsor. U.S. Army Forces Command.

12. Performing Organization and Principal Authors.

RAND Arroyo Center, 1700 Main Street, Santa Monica CA 90407
Authors: Thomas F. Lippiatt (POC, 310/393-0411, Ext. 6507),
James C. Crowley, Patricia K. Dey, and Jerry M. Sollinger.

13. Literature Search. In addition to RAND's own holdings, Army publications and research of other organizations were reviewed and cited.

14. DTIC Accession Number. ADA319236

15. Start and Completion Dates. January 1994 - February 1996.

Joint Precision Strike Demonstration
Combined Forces Command
Counterfire Study

Study Gist

STUDY PURPOSE. To conduct an analysis of CFC OPLAN and examine the counterfire fight of the Third Republic of Korea Army (TROKA) versus the North Korean (nK) 1st Operational Echelon Force (OEF), with specific emphasis on the effects of the JPSD technologies on the nK 240mm Multiple Rocket Launchers (MRLs) and 170mm Guns at their forward-based underground facilities (UGFs).

CRITICAL ISSUE(S) ADDRESSED. The study addressed the issues of structuring and equipping. What is the force effectiveness of the current organizational structures and operational plans? What is the increase in force effectiveness in relation to specific force enhancements?

OBJECTIVE(S). The objective was to determine the force effectiveness of the counterfire fight of TROKA versus the nK 1st OEF, per the current OPLAN and several proposed alternatives.

PRINCIPAL FINDINGS. Improvements in force effectiveness were demonstrated in the alternatives as compared to the base case (current OPLAN). Specific findings and insights are classified SECRET/ROKUS.

IMPACT/UTILITY TO THE ARMY. Past CFC analytical efforts focused at the theater level. This study marked the first time that a higher resolution (corps/division-level) analytical simulation model was used to examine the force effectiveness of the TROKA counterfire fight. TRAC's findings will provide analytical underpinnings for the CFC commanders and staffs as they work to obtain key decisions from their CINC and to update OPLAN . The preliminary findings have resulted in changes to the theater's Integrated Tasking Order (ITO). Options currently being considered by the theater, as a result of the study conclusions and insights, include switching missions for some MLRS batteries, further changes to the ITO, and a reprioritization of in-theater assets.

MAIN ASSUMPTIONS. Main assumptions are classified SECRET/ROKUS

PRINCIPAL LIMITATIONS. The principal limitations were:

- Weapons of mass destruction were not modeled due to user defined inputs.

- The air-to-air battle was not explicitly modeled. Data on the expected number of threat sorties that could get through the Defensive Counter Air missions was provided by the National Air Intelligence Center (NAIC).

- Only the combined arms fight in the TROKA sector, vice the entire theater front, against the nK 1st OEF was examined due to model and time limitations.

- The damage to cities, fixed facilities, and infrastructure was not modeled due to model limitations.

SCOPE. The study examined the combined arms fight, with focus on the counterfire battle, between TROKA forces and the nK 1st OEF forces in the initial 72 hours of an unannounced war. The base case force structures, organizations, unit locations, and Tactics, Techniques, and Procedures (TTPs) were per the theater's OPLANs and the theater's Peninsula Intelligence Estimate (PIE). Adjustments were made for the alternatives as directed by the sponsors Sensitivity runs were also made to conduct "what if" analysis.

APPROACH. A team of six analysts from TRAC-Fort Leavenworth was given the mission to conduct the study. The scenario reflects the present theater OPLAN s and the present theater's threat estimates, while focusing on the initial 72 hours of an unannounced war with applicable assumptions. The models used were Vector-In-Commander (VIC) and Extended Air Defense Simulation (EADSIM). The study consisted of a base case (OPLAN), four alternatives: a TROKA Alternative (OPLAN with additional ROK artillery assets), a CFC Reinforced Alternative (OPLAN reinforced with additional US artillery assets), a JPSD Alternative (OPLAN with JPSD technologies), a JPSD Reinforced Alternative (OPLAN reinforced with US artillery assets and JPSD technologies), and several sensitivity runs.

STUDY SPONSORS. The study co-sponsors are the Joint Precision Strike Demonstration Project Office (JPSD PO) and the Combined Forces Command (CFC).

PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS. TRADOC Analysis Center, Fort Leavenworth, Kansas, 66027. The study director is MAJ Mike Boller, DSN 552-3334, or commercial phone (913) 684-3334. Study POC is LTC Hoa Generazio, DSN 552-9278, or commercial phone (913) 684-3334.

LITERATURE SEARCH. A review of the theater-level resolution studies that the Concepts and Analysis Agency (CAA) had performed for CFC was conducted. Studies conducted on unmanned aerial vehicles (UAVs) and assessments of bomb damage against fortified positions were reviewed and implemented. This effort marked the first time that a corps-division level analytical model was used to conduct an analysis on CFC's OPLANs.

DTIC ACCESSION NUMBER. DA353514.

START AND COMPLETION DATES. January 1996 - December 1996.

Antiarmor Requirements and Resource (A2R2) Analysis (U)

Study Gist

Study Purpose. The purpose of the A2R2 Analysis was to provide an updated assessment of antiarmor munitions and systems requirements to support the building of the Army's 98-03 program objective memorandum (POM). This document contains the results of the requirements analysis for the A2R2 Analysis.

Critical Issues Addressed. This analysis provided an updated assessment of the Army's antiarmor systems and munitions requirements, integrated capabilities, and value-added projected out to the years 2005 and 2015. During the course of the study, the study sponsor directed that a further assessment be made of key systems in the year 2005 base case using the year 1999 systems as the base case.

Objective. Provide to the study sponsor (1) the optimum family of antiarmor systems/munitions considering both lethality and survivability and (2) a 1-N list of antiarmor systems/munitions considering both effectiveness and cost.

Principal Findings. The results of this study provided very lengthy and detailed findings. Each section of the study, year 1999, year 2005, and year 2015 contains insights from each scenario analyst and Mix Model results consisting of costing impacts, best families, and 1-N lists.

Impact/Utility of the Army. The results of the analysis provided detailed information to the decision makers in the building of the 98-03 POM. This information established a basis on which decisions could be made on how best to spend limited resources on systems and/or munitions to maintain an efficient and effective fighting force for future years.

Main Assumptions. The primary assumption made for the requirements analysis was that a high-technology Threat, consisting of weapon systems that would be available on the world market, was more appropriate for planning future requirements for United States (US) systems for the far term (year 2015) portion of the analysis, than weapons systems that would have been projected for areas within Defense Planning Guidance.

Principal Limitations. Stingray (CPS-H)/Outrider (CPS-L) alternative systems in the heavy/light scenarios were played implicitly. Due to modeling constraints, all Threat systems with forward looking infrared (FLIR) capability switched from direct view optics (DVO) to FLIR when Stingray/Outrider were employed. Because of the implicit portrayal of Stingray/Outrider, the Stingray/Outrider results were not used in the Mix Model analysis.

Scope. The study was divided into two phases to consider the near term (year 2005) and the far term (year 2015). The analysis covered both the close and deep battle problems and, where possible, considered implications of Task Force XXI (TF XXI) concepts. The Training and Doctrine Command (TRADOC) Analysis Center (TRAC) was tasked to conduct a requirements analysis of close and deep systems/munitions in seven high/low resolution scenarios appropriate to contingencies in Defense Planning Guidance. Results were supplied to the US Army Concepts Analysis Agency (CAA) for performance of the resource analysis. The US Army Materiel Systems Analysis Agency (AMSAA) was tasked to perform a performance and sustainability analysis on all systems considered in the requirements analysis. The TRADOC system managers

and TRADOC schools and centers participated in the selection of systems for the near and far terms and in the development of employment tactics, techniques, and procedures for representation in the combat models. Army Materiel Command (AMC) program managers provided data and costs for the systems under review. The TRADOC Deputy Chief of Staff for Intelligence (DCSINT) element at Fort Leavenworth provided a review of all scenarios and supplemented the analysis with development of a high-technology Threat force for the far term.

Approach. The methodology for conducting the requirements analysis consisted of running each alternative system or munition in a high resolution (brigade level) model in five scenarios (three heavy and two light) to determine the value added by that system to either the heavy or light ground forces. Systems that provided a capability for the corps deep battle were also examined in a corps level model in two scenarios. The scenarios were equally divided between Northeast Asia and Southwest Asia. The number of armor kills and the number of US systems/personnel saved were the primary measures of effectiveness. The integration technique for the brigade resolution and corps resolution results was to develop the measures in terms of percent increases to the base case for both lethality and survivability. The requirements analysis used data approved by AMSAA and in each scenario employed a far term high technology Threat force supplied by the TRADOC DCSINT element at Fort Leavenworth. The most effective family of systems/munitions was rerun in the combat models to adjust coefficients for the synergistic effects of combinations of systems.

Study Sponsor. Director, Force Development, Deputy Chief of Staff for Operations (DCSOPS), Department of the Army (DA).

Performing Organization and Principal Authors. This requirements analysis was performed by the TRADOC Analysis Center-White Sands Missile Range (TRAC-WSMR), Study Director, Mr. Richard Porter, DSN 258-4300, with assistance from the TRADOC Analysis Center-Operations Analysis Center (TRAC-OAC), Team Leaders - Ms. Melinda Sanders and Ms. Sharon Wagner, DSN 552-9246. In addition to the study director and the TRAC-OAC team leaders, the principal authors were the following: LTC George Cherolis, Near Term Study Manager, MAJ Benson Davis, Far Term Study Manager; Mr. Stanley Gray, HRS 31 Team Chief, Ms. Barbara Borchardt, HRS 38 Team Chief for Near Term; Mr. William Leach, HRS 38 Team Chief for Far Term; Mr. Barney Watson, HRS 43J Team Chief; MAJ Geoffrey Coleman, HRS 52 Team Chief for Near Term, Mr. Tom Loncarich, HRS 52 Team Chief for Far Term, CPT Michael Wallace HRS 52 Far Term Analyst; Mr. David Kelley, Team Chief for HRS 58; and Mr. Richard Laferriere and Mr. Bruce Gafner, Mix Model Analysts. The resource analysis was accomplished by CAA, LTC Rodger A. Pudwill, DAN 295-1609. The system performance and sustainability analysis was accomplished by AMSAA, Mr. Ron Thompson, DSN 298-5024.

Literature Search. Not applicable to this analysis.

DTIC Accession Number. DA358605

Start and Completion Dates. March 1995 - March 1996

Countermine Technology Analysis — Study Summary

TRAC WSMR

Purpose. The countermine technology analysis addressed how emerging countermine technologies affect the dismounted soldier's capabilities in mine detection, clearing and avoidance during combat operations, and operations other than war (OOTW).

Critical Issue Addressed. This study examined potential mine detection and breaching technologies which could supplant or supplement current equipment.

Objectives. The objectives of the countermine technology analysis were: (1) to compare the effectiveness of future dismounted countermine technologies with current equipment, and (2) to investigate the impact on battle outcomes of known minefield locations versus surprise encounters of minefields.

Principal Findings. Findings are listed by essential elements of analysis (EEA) and further broken down by the two scenarios used in the study; expand the lodgment (ETL) and OOTW.

EEA 1. How effective are future countermine breaching technologies compared to current technologies?

ETL. Current technologies are the AN/PSS-12 and the hand grapnel hook. Against pressure mines, the percent breachers lost while breaching was lowest for alternatives with the Anti-Personnel Obstacle Breaching System (APOBS). This was true whether used by itself or with other future countermine technologies. Against tripwire mines, the Airborne Standoff Minefield Detection System (ASTAMIDS) alternatives with the launched grapnel hook (LGH) had the lowest percentage of breachers lost.

OOTW. Against tripwire fuzzed mines, breacher losses to mines were lowest for alternatives with APOBS. Against pressure fuzed mines, breacher losses to mines were lowest for alternatives with APOBS and alternatives with the Close-In Man Portable Mine Detector (CIMMD). In all cases, future countermine technologies outperformed current technologies.

EEA 2. Are Blue losses for forces equipped with future countermine technologies significantly different from forces equipped with current equipment?

ETL. For alternatives with ASTAMIDS and pressure mines, Blue losses to mines were the lowest with APOBS. Differences in Blue losses to mines were not discernible between alternatives without ASTAMIDS. For alternatives with tripwire mines, Blue losses to mines were discernibly lower for alternatives with new countermine technologies. No single technology or combination stands out.

OOTW. Against pressure fuzed mines and tripwire fuzed mines, Blue losses to mines were significantly lower for alternatives with APOBS.

EEA 3. What effect does knowing minefield locations through the use of ASTAMIDS have on Blue losses?

ETL. Blues losses to pressure mines were reduced 85 to 97 percent with

ASTAMIDS. Blue losses to tripwire mines were reduced 30 to 60 percent.

OOTW. ASTAMIDS reduced Blue losses an average of 69 percent in alternatives with tripwire fuzed mines, and an average of 76 percent in alternatives with pressure fuzed mines.

Impact/Utility to the Army. The results of this analysis could help assist deciding which countermine technologies show promise for further development and possible acquisition.

Main Assumptions. Anti-personnel land mines are a significant threat to dismounted infantry forces and future countermine technology performances are adequately expressed in current data projections.

Principal Limitations. Final countermine system configurations were unknown or undetermined. Therefore, performance data for future countermine technologies was based on engineering estimates.

Scope. This analysis evaluated the influence of encountering known and unknown minefields with current inventory dismounted countermine equipment and with equipment based on proposed technologies. The analysis examined two threat minefield types: one type contained pressure initiated mines and the other tripwire initiated mines. Force structures with single countermine types were examined as well as structures with a mix of different types of countermine equipment. The Blue force was a dismounted infantry company with a squad of engineers attached.

Approach. The high resolution combat model CASTFOREM was used to simulate the use of various countermine equipment in battle. Proposed countermine equipment replaced current equipment and was evaluated against pressure fuzed or tripwire fuzed mines. All other systems remained constant. Alternatives were grouped by pressure or tripwire mines and whether or not minefield locations were known. Two scenarios were used. ETL involved a covert dismounted infantry company breach at night. In OOTW, an infantry platoon escorts a United Nations convoy. A squad of engineers is attached to clear any mines found along the convoy route. The scenarios were developed at TRAC-WSMR with input from the Infantry and Engineer Schools. Measures of effectiveness (MOE) included number of Blue personnel losses and percent breaching devices lost while breaching.

Study Sponsor. US Army CECOM, ATTN: AMSEL-RD-NV-MD-DA, 10221 Burbeck Road, Suite 430, Fort Belvoir, VA 22060-5806

Performing Organization and Principal Authors. TRADOC Analysis Center-White Sands Missile Range (TRAC-WSMR), ATTN: ATRC-WAD, White Sands Missile Range, NM 88002-5502. Authors were Mr. Jeffrey Kramer (DSN 258-2249) and CPT Mark Moulton (DSN 258-1370).

Literature Search. Not applicable to this analysis.

DTIC Accession Number. DA358606.

Start and Completion Dates. February - November 95.

CAA	Warfighting Analytical Support to Third U.S. Army (WAS-TUSA)	STUDY SUMMARY CAA-MR-95-84

1. **STUDY TITLE.** Warfighting Analytical Support to Third U.S. Army (WAS-TUSA).

2. **STUDY PURPOSE.** To provide on site, responsive, real time, warfighting analytical support for the planning and conduct of theater level combat operations.

3. **CRITICAL ISSUE(S) ADDRESSED.** Through Desert Storm, warfighting analysis has been limited to supporting the deliberate planning process. The norm of today's less stable environment is one which demands crises action planning. Today's technology provides the necessary leverage. The central issue is how to leverage that technology to provide responsive warfighting analytical support.

4. **OBJECTIVE(S).** Provide an analytic capability to the theater level commander which enhances his course of action development, operational war planning, and campaign execution.

5. **PRINCIPAL FINDINGS.** The principle findings are the result of demonstrated performance during several joint and combined theater level exercises conducted in CONUS and OCONUS.

a. Warfighting analytical support can be deployed and provided on site to the theater level commander in CONUS and OCONUS.

b. Course of action development can be enhanced multifold enabling the planning staff to consider exponentially more than the typical three courses normally examined.

c. Computer assisted campaign modeling can be conducted to wargame courses of action well within the crises action decision making cycle.

d. Decision graphics can be defined and developed to rapidly facilitate theater commander's decision making in the operational and doctrinal context.

6. **IMPACT/UTILITY OF THE ARMY.**

a. The capability provided by WAS-TUSA is routinely employed by the Third U.S. Army and occasionally by the U.S. Central Command to support warfighting contingency plan development and major joint and combined training exercises.

b. This capability is currently designated to deploy to southwest Asia to provide warfighting analytical support in the event of a major regional contingency in the region.

7. **MAIN ASSUMPTIONS.**

a. Commander critical information requirements are necessary to enable the theater level commander to make warfighting decisions.

b. Current technology provides the necessary leverage to provide on site, responsive, real time warfighting analytical support for the planning and conduct of combat operations.

c. The military decision making process and the campaign analysis process have sufficient commonalties to bridge between the art and science of warfighting.

8. **PRINCIPAL LIMITATIONS.** WAS-TUSA was designed to focus strictly on course of action development, analysis and comparison for theater level warfighting. This limitation, therefore, excluded consideration of deployment optimization, logistical requirements and consideration of operations other then war (OOTW).

9. **SCOPE.** The effort encompassed the specific areas of:

a. Course of action development for both friendly and threat forces at the grand tactical and operational level. This is a departure from the campaign analysis process where the threat course of action is typically held constant. Additionally, the branches and sequels to both the friendly and threat forces were included in this development rather than limiting consideration to only the primary branch as defined by the original courses of action which are normally generated by the planning staff.

b. Combat modeling incorporated both air and land combat at the operational level as well as coalition, and land and air forces from all the services.

c. Decision graphics were developed using standard military doctrinal displays which provided commander critical information requirements both quantitatively and qualitatively.

10. **APPROACH.** The approach taken was multifold. First, to identify the commander's critical information requirements (CCIR) necessary for the theater level commander to make operational warfighting decisions. Second, to migrate a theater level campaign model from a Cray main frame onto a laptop computer. Third, merge the military decision making process with that of the campaign analysis process thus bridging between the art and science of warfighting. This merger brought together those attributes of each process which offered the greatest benefit to providing the which were identified in the first step. Finally, with a process designed to produce the necessary CCIR, the ADP technology available was configured to support the merged processes.

11. **STUDY SPONSOR.** Third U.S. Army.

12. **PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS.** U.S. Army Concepts Analysis Agency, COL James L. Hillman and LTC Wm. Forrest Crain.

13. **LITERATURE SEARCH.** Research of previous efforts to provide this capability was conducted in both the combat modeling and military planning and decision making fields. In the combat modeling arena, no evidence was found which identified a combat modeling capability which could provide a deployable, on site, operational level campaign analysis capability. Research of military planning and decision making identified that U.S. CENTCOM deployed a combat modeling capability to southwest Asia during the Gulf War, but this capability was limited to deliberate planning and lacked the robustness to assist in course of action development and the was not responsive enough to support warfight analysis in crisis action planning much less support decision making during the conduct of the operation.

14. **DTIC ACCESSION NUMBER.** N/A.

15. **START AND COMPLETION DATES.** While the study has a definite start and completion date, the capability provided by this effort continues to be employed and refined. For the original effort the start and completion dates were:

a. Start: 24 April 1995.

b. Completion:31 December 1995.

STUDY GIST

1. STUDY TITLE: Low Cost Competent Munitions (LCCM) Effectiveness Analysis.

2. PURPOSE: To support a joint ARDEC-ARL Tech Base program by recommending a development strategy for Low Cost Competent Munitions.

3. CRITICAL ISSUES ADDRESSED: a. Development programs, such as the XM982 Extended Range Ammunition (ERA) and the Crusader SPH, will eventually enable tube artillery attack of targets into the 30 to 50 km range band. Due to accuracy limitations of unguided projectiles, effectiveness at these ranges will be severely hampered, especially if unobserved, predicted fire techniques are employed.

b. Early entry contingency missions will also benefit from projectile accuracy enhancements. During the initial deployment stages of many contingency missions United States troops may find themselves fighting both outnumbered and with limited supplies of available ammunition. More accurate and timely artillery support at all ranges - from max range down to final protective fires - could significantly increase the prospect for a successful mission through more responsive attack of time-critical targets and conserving ammunition while providing more effective fire support.

c. Finally, the enormous stockpile of currently existing artillery ammunition could be made significantly more effective at relatively low cost if their accuracy be improved through a fuze solution.

4. OBJECTIVE: The objective of the LCCM program is to improve the accuracy and effectiveness of cannon artillery fire (especially at extended ranges of 40+ km) by developing low cost fuze located enhancements. These enhancements will be applicable to both current and future projectiles and will fit within a NATO-standard fuze.

5. PRINCIPAL FINDINGS: Three fuze solutions were evaluated in this study: 1) GPS Auto-registration module, 2) Drag Induced Range Correction Module (1-D Corrector), and Canard Guidance Module (2-D Corrector). Conclusions of the study were:

a. LCCM did improve round efficiency: Auto-registration - up to 70 percent improvement; 1-D Corrector - ½ hr MET up to 80 percent improvement - 4 hr MET up to 63 percent improvement; 2-D Corrector - up to 89 percent improvement

b. Improvement in efficiency was range dependent.

c. 1-D and 2-D concepts are most sensitive to target location error (TLE) increases.
d. There is a diminishing return with increasing the number of registration rounds.

6. IMPACT/UTILITY OF THE ARMY: As this program is currently a 6.2 technology base effort, no official requirement has been established. LCCM does however, address critical Field Artillery Future Operational Capabilities (FOC) as expressed by the Army Training and Doctrine Command (TRADOC). These include:

a. FA 97-001, Attack Targets at Depth -- Capability of field artillery systems to attack targets out to 500 km to adequately defeat future missile threats and to conduct precision strikes against other critical targets.

b. FA-97-020, First Round Kill -- Field artillery indirect fires must be capable of hitting and destroying targets to an extent that each shot fired equals one or more kills. This capability is necessary to achieve the precision lethality required for shaping the battlefield and decisive operations. It is also required for reducing the considerable ammunition resupply burden on an increasingly fluid battlefield. The vastly improved accuracy and lethality of Field Artillery munitions and sub munitions is a vital factor in accelerating an enemy's defeat.

Results of this study contribute to the evaluation or management of the LCCM program.

7. MAIN ASSUMPTIONS: The LCCM time frame will extend through 2010. Tube artillery weapon systems capable of reaching 40-50 km will be available during the LCCM time frame (e.g. Crusader ca. 2006). Extended range ammunition capable of reaching 30 - 35 km with current artillery systems will be available during the time frame of the study (e.g. ca. 2001). Future as well as current weapon systems and projectiles will be compatible with the LCCM technologies and/or design features.

8. PRINCIPAL LIMITATIONS: Study considered only projectile-related solutions to the artillery accuracy problem. The analysis was limited to a representative set of projectiles and engagement scenarios. As LCCM is currently in an early stage of development (6.2), a Cost and Operational Effectiveness (COEA) level force-on-force analysis is beyond the scope of this effort.

9. SCOPE: The analysis investigated the value of LCCM accuracy improvements by evaluating their performance in various types of 155mm projectiles against a selected set of targets, firing ranges and target location errors, reflecting early entry as well as heavy battle scenarios. Performance at ranges attainable by future howitzers (e.g. 40 to 50 km) as well as current artillery was examined. Study Parameters included:

Weapon Platforms: Paladin, M198, Crusader, LW155
Munitions: M483A1, M864, XM982, M549A1, M107
Gun to Target Ranges: 15km, 20km, 25km, 35km, 45km
MET Data: ½ hr, 2 hr, 4 hr, Standard
Target Location Error (TLE) - 100 meters for all targets
- excursions showing TLE sensitivity

Aiming Policy: Modified Fendrikov
Number of Guns: Most efficient number for each parametric case
Delivery Accuracy Data: AMSAA data
Target Sets included:

- Self-Propelled Howitzer Battery
- Towed Howiter Battery with Prone Protected Personnel
- Towed Howiter Battery with Standing Personnel
- Air Defense Radar - Point Target

10. APPROACH: Examine the relative benefits of several accuracy improvement concepts for projectiles in terms of terminal effectiveness. Obtained a technical description of each LCCM concept. Established baseline conditions for determining accuracy (e.g. types and sizes of firing unit ranges and MET conditions). Determined what technical data must be provided in order to calculate accuracy data. Gathered the required technical data. Determined the accuracy data (bias and precision) for the baseline conditions and for each LCCM concept. Determined a representative set of targets, ranges and target location errors to use in performance calculations. Calculated effectiveness for appropriate combinations of LCCM and target scenario. The Smart Munitions Analysis Code (SMAC) was the primary performance model used for analyzing required projectile-target combinations. The measure of effectiveness used during this analysis was the number of rounds required to achieve a fractional casualty (fc) level of 10 percent and 30 percent. A maximum of 500 rounds were fired to achieve this level. Each projectile was evaluated for 7 accuracy conditions which include:

- Predicted fire ½ hr MET
- Predicted fire 2hr MET
- Predicted fire 4hr MET
- Predicted fire standard MET conditions
- Auto-Registration using 4 rounds
- 1-D Range Correction Module
- 2-D Canard Guidance Module

11. STUDY SPONSOR: Ms. Renata Price, Assistant Technical Director for Technology OSARDA.

12. PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS:

Ingrid M. Dombroski - DSN 880-4167
Donna L. Snyder - DSN 880-6657

Simulation and Analysis Division, ARDEC (TACOM)

13. LITERATURE SEARCH: The Artillery Accuracy and Effectiveness Working Group was contacted to ensure that no similar studies have been performed.

14. DTIC ACCESSION NUMBER: DA352168

15. START AND COMPLETION DATES: 1 Oct 95 - 30 Sep 96 (Phase I).

STUDY GIST

(Gist is UNCLASSIFIED. Study (not attached) is SECRET)

1. **STUDY TITLE**: Advanced Intelligent Submunition (AIS) [Damocles] Sensitivity Analysis.

2. **STUDY PURPOSE**: To determine the sensitivity of AIS performance to critical parameters in an MLRS guided rocket.

3. **CRITICAL ISSUES ADDRESSED**: The critical issue was the goodness of the goals (specifications) for submunition fly out pattern, submunition footprint size, detection probability, classification probability, counting logic, false target density, panic mode, and winds when launching the submunition in the guided Multiple Launch Rocket System (MLRS) rocket.

4. **OBJECTIVES**: The objective was to determine a specification for the submunition that would allow it to meet the MLRS Smart Tactical Rocket (MSTAR) operational requirements. Alternatively, it was to evaluate the ability to design an AIS-like submunition that could meet the requirements.

5. **PRINCIPAL FINDINGS**: The study determined a performance specification for the AIS that is considerably less stringent than the current set of goals, indicating that a sensor design that failed to meet detection, classification, and false target goals can still meet the MSTAR requirements. The finding was limited to stationary targets and moving targets with less than 600m target location error (TLE).

6. **IMPACT/UTILITY TO THE ARMY**: The study will contribute to more intelligent requirements. It may also contribute to the MSTAR decision.

7. **MAIN ASSUMPTIONS**: The main assumptions of the study are that the draft MSTAR requirements will be approved without substantial changes, that AIS is a candidate submunition, and that AMSAA data on warhead lethality is valid.

8. **PRINCIPAL LIMITATIONS**: The study views AIS performance based on data and requirements known in the study time frame (April 1996). Since the AIS is early in its development cycle, that data may change.

9. **SCOPE**: The study examined the above mentioned sensitivities against six threat

arrays and for five levels of TLE (ranging from 0-1500m). Two fly out patterns were considered. Five footprint sizes were analyzed. Probabilities were systematically varied from 0 to 1. False target densities were considered from 0 to 30 per square kilometer. An exhaustive approach was also taken with counting logics and panic mode entry times.

10. **APPROACH**: The basic approach consisted of three phases. Phase one consisted of establishing the correct data and the analysis model (research). Phase two consisted of study runs (modeling). Phase three involved documenting the model developed and the results obtained (documentation).

a. In phase one, the current draft requirements were obtained and reviewed with the Technical Systems Manager - Rocket and Missile Systems (TSM-RAMS). The performance data used in previous studies of AIS in MLRS was likewise obtained and confirmed. The Smart Munitions Analysis Code (SMAC) was upgraded to allow for modeling of relevant features of AIS. Finally, the results of SMAC runs were compared to previous study results from the GENESIS model.

b. In phase two, the study runs were made, verified, and analyzed. Meetings were held with the contractor and the project engineer to discuss the emerging results. A briefing was also given to DUSA-OR (Mr. Walt Hollis).

c. In phase three, a technical report was written and disseminated to Army Materiel Systems Analysis Activity (AMSAA), TSM-RAMS, and Depth and Simultaneous Attack Battle Lab (D&SABL). It will be formally published as a DTIC report after a reasonable period of review.

11. **STUDY SPONSOR**: US Army ARDEC Precision Munitions Division.

12. **PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS**: U.S. Army Tank-Automotive and Armaments Command, Armaments Research, Development, and Engineering Center (ARDEC), Simulation and Analysis Division, Fire Support Armament Center. Principal investigator and author is Daniel A. Ericson, DSN 880-6643, AMSTA-AR-FSS.

13. **LITERATURE SEARCH**: Operational Requirement Document for MSTAR. Interim Report and Briefings for the MSTAR Study. Army Materiel Systems Analysis Activity (AMSAA) Notes and Correspondence. Illonois Institute of Technology Research Institute (ITTRI) Notes, Briefings, and Correspondence. TSM-RAMS MSTAR Briefings. Contractor Briefings and Reports. DTIC Not Utilized Due to Newness of

System.

14. **DTIC ACCESSION NUMBER**: DA337378.

US ARMY CORPS OF ENGINEERS

Army Study Highlights Study Gist

Intelligence Preparation of the Battlefield (IPB) Process Value Added Via Automated Geo-Referenced Mobility Algorithms and Products

STUDY PURPOSE

IPB process functions at brigade and below are time intensive procedures typically performed manually under critical time constraints. The brigade intelligence officer must depend largely on reconnaissance of available materials to address the commander's needs. However, the interpretation of accessible materials is subjective and often not sufficient for these requirements. Automated procedures, such as those which perform ground vehicle mobility assessments, exist but are not readily available at brigade and lower. These procedures potentially offer increased quality, consistency, objectivity, and completeness in products and analyses as well as time savings to the analyst.

The purpose of this study was to determine the utility and benefits of employing computer-based automated, interactive mobility assessments in the IPB process at echelons brigade and below. This value added analysis of automated functionality was needed to provide practical insight regarding the impact of automation on users and on processes and to reveal system development needs. The U.S. Army Engineer Waterways Experiment Station, with over 40 years of research and development experience in ground vehicle mobility, conducted this study during FY96.

CRITICAL ISSUES ADDRESSED

The study primarily related to two Army critical issues as identified in the call for study submissions. (1) Digitization of the Battlefield: The study dealt with performing mobility-related IPB functions with computer systems to display digitized decision aids/products over digitized map backgrounds of the area of interest by utilizing computer-based Geographic Information System (GIS) interfaces. (2) Modernization: Automated IPB analysis and assessment capabilities at brigade and lower levels provide for improved product quality in terms of completeness, integration, and clarity; a more rapid analytical process; and time savings.

OBJECTIVE(S)

The objectives of this study were to: (1) identify mobility-related IPB functions that can be performed using automated, geo-referenced means at brigade and below and (2) evaluate resultant value added to the IPB process, if any. Time to conduct tasks, quality of products, insight into analyses, scores on tasks trained, and perceived importance/priority regarding automation of specific IPB elements were addressed.

PRINCIPAL FINDINGS

Twenty-one mobility-related IPB process components (functions and major products of the process) were identified and evaluated; results indicated their automation, with respect to mobility assessment at brigade and below, would indeed add value to the process.

1. Data collected during experiments carried out in conjunction with the Military Intelligence Officer Advanced Course (MIOAC) at Fort Huachuca, Arizona indicated automation promotes

greater consistency among products, reduces time required to perform various functions, improves accuracy and detail of analyses, and improves mission analysis and courses of action development and analysis.

(a) Controlled experiments demonstrated simulated brigade staffs utilizing automated geo-referenced mobility decision support systems (i.e., computer-assisted staffs) were able to conduct certain elements of the IPB process in statistically significantly less time than staffs in conventional manual roles. Elements measured were the creation of the Modified Combined Obstacle Overlay (MCOO), Time Phase Lines, Situational Map Overlay, Course of Action Development, and Wargaming.

(b) Results from controlled experiments revealed computer-assisted brigade staffs scored higher on exercise evaluations, on a question-by-question basis, than did conventional manual staffs.

(c) Examination of products, such as the MCOO, showed there was greater detail and consistency among computer-assisted staffs as compared to manual staffs. Computer-assisted staffs developed their analyses on a common, larger battlespace than did manual staffs and more accurately portrayed products such as Time Phase Lines representing unit progression at given time increments.

2. The general perception within the Military Intelligence (MI) community, as indicated by over 150 questionnaire responses, was automation will help (according to 92% of respondents), as opposed to hinder (3%) or not make a difference (5%), in the IPB process. No IPB process component evaluated was considered by a majority of respondents as "not important" to automate.

3. Study participants overwhelmingly indicated automation of IPB process elements at brigade and below was a welcomed advancement; they provided feedback, which was incorporated into recommendations, regarding development of future systems with automated IPB functionality.

4. Questionnaires answered by Army S2 staff and MIOAC participants resulted in developing a relative rank ordering of IPB process elements based on perceived priority for automation. Elements were differentiated as products and functions contributing to product development. The MCOO was the highest priority product to automate. Mobility corridors and avenues of approach were among the top ranking functions.

IMPACT/UTILITY TO THE ARMY

Several recommendations were developed based on study results: (1) automate, as a minimum, mobility-related components of the IPB process at brigade and below, (2) provided brigade and below automated IPB capability on a standard platform and link to IEW technology initiatives/applications, promoting greater usability, (3) standardize symbols, colors, and terminology in menus, legends, and displays, (4) supply results of calculations quickly and accurately to ensure utility of automated (computer) capabilities, (5) provide capability to modify automated results based on user insight and up-to-date intelligence information, (6) simplify

software to minimize training and personnel requirements, (7) involve computer operators and product recipients in software/system evaluation and training to increase acceptance of automated products, and (8) conduct follow-on analysis to determine how to best generate and present information to facilitate synthesis/understanding of results.

Implementation of recommendations would have a direct impact on operations at brigade and below. Furthermore, the study methodology provides the Army with a prospective framework for evaluating the impact of decision support technologies and battlefield digitization on performance.

MAIN ASSUMPTIONS

(1) The MIOAC exercises reasonably simulated brigade staff operations and provided an environment for direct comparisons between manual and computer-assisted IPB functionality.

(2) Reference questionnaire results. The sample of Army S2 staff and MIOAC students was representative of the target population (MI officers knowledgeable regarding the IPB process at brigade and below).

PRINCIPLE LIMITATIONS

During the study time frame (FY96), it was possible to run full-scale experiments with two MIOAC sections due to course scheduling at the Intelligence School. Although enough data was gathered to provide statistical significance, more data points were desirable. Due to time and personnel constraints, experiments were not carried out with maneuver units to evaluate the impact of automated IPB functionality. Note, direct comparisons between automated and manual performance were not possible with maneuver units because they do not have duplicate staffs performing IPB for the same mission in the same area of operation as in the MIOAC; thus, experiments in controlled environments where direct comparisons could be made (i.e., MIOAC) were deemed more beneficial to the study.

SCOPE

The focus of this study was on evaluating value added at echelons brigade and below. Mobility assessment tools and applications in the IPB process which are tightly coupled with mobility assessments were considered. Study emphasis was on mobility-related IPB elements rather than on software systems. The study was not an evaluation of any particular computer-based system, nor did it provide a review of all computer-based software systems containing mobility assessment products. Researchers served as computer operators to provide automated results/products to staffs and eliminate training effects and system influence on results.

APPROACH

The study incorporated formal hypotheses testing, analytical rigor, and soldier involvement. A thorough review of the IPB process was carried out initially and involved significant interaction with the MI community. Mobility-related IPB process components were identified in this phase. To assess value added, two approaches were employed to obtain results from a representative cross-section of the MI community: designed experiments and questionnaires. Pilot experiments and pre-tests of questionnaires were conducted to determine needed modifications. Over 250

officers participated in the study.

Designed experiments were used in the first approach to compare performance of brigade staffs with automated versus manual IPB functionality. Trained computer operators (researchers) provided automated products during MIOAC experiments because systems were not being evaluated. Trained process observers recorded times and observations during MIOAC experiments. Analysis of variance was used to evaluate results from the randomized block designs to determine if computer-assisted staffs performed significantly better in terms of evaluation scores than manual staffs. Paired sample t-tests were utilized further to investigate results on a per-evaluation-element basis. Nonparametric analysis of in-process measurements (e.g., times to produce products) was conducted since the assumption of normality was not applicable.

The second approach involved utilizing questionnaires to obtain information regarding perceived value in automating mobility-related IPB functions. Questionnaires were disseminated to participants in the MIOAC and active S2 staff throughout the Army. Respondents were asked to independently rate the importance of automating specified IPB elements and then rank order the items in order of priority for automation. Sample size was 151 respondents and exceeded predetermined sample size needed. Multivariate cluster analysis and categorical data analysis were used to evaluate perceptions concerning value added in automating IPB process components and to determine a prioritization for automation of elements.

STUDY SPONSOR

The study was sponsored by the Office of the Deputy Chief of Staff for Intelligence, Headquarters, Department of the Army. POC: Mr. Steve Nolan, DAMI-PPM.

PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS

The study was performed by the U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

Principal Authors were Dr. Niki C. Deliman, Mr. Alex Baylot, Mr. Jeff Williamson, and Ms. Laura Bunch. The study was directed by Dr. Niki C. Deliman (601-634-3369).

LITERATURE SEARCH

A DTIC literature search was performed prior to conduct of the study. Additionally on-line (key word and subject based) and library searches were carried out to identify related research. It was determined this study had not been previously performed.

DTIC ACCESSION NUMBER

Report in publication through U.S. Army Engineer Waterways Experiment Station; DTIC number not yet assigned/available.

START AND COMPLETION DATES

Start Date: 10/95 Completion Date: 9/96

ACKNOWLEDGMENT

The tests described and the resulting data presented herein, unless otherwise noted, were obtained from research conducted under the FY96 Army Study Program and sponsored by the Office of the Deputy Chief of Staff for Intelligence. Permission was granted by the Chief of Engineers to publish this information.

1996
Dr. Wilbur B. Payne Memorial Awards
for Excellence in Analysis

Citations

Individual Author

Dr. Dwayne W. Nuzman, Operations Research Analyst, Combat Integration Division, US Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD, is commended for his research, represented by his paper, *Statistical Comparison of Multi-Dimensional Distributions*. Dr. Nuzman has developed and applied a new approach to statistical comparison of multivariate data. The new method can detect differences in simulations that would not be detectable by more traditional methods. The approach was applied to the evaluation of the Anti-Armor Advanced Technology Demonstration experiments and validation in the Target Acquisition Model Improvement Program. Live, virtual and constructive simulations will be used in the future to support acquisition decisions. Live and virtual simulations will have to rely on small sample sizes. Dr. Nuzman's method will allow rigorous statistical comparisons to support validation efforts and will find application in target identification and target discrimination in the visual acquisition process where multivariate data must be compared. For this innovative development and refinement of analytical techniques, Dr. Dwayne W. Nuzman has been selected to receive the 1996 Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis.

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Group Authors

Professor Donald R. Barr, Department of Systems Engineering, and **Major E. Todd Sherrill**, Operations Research Center, US Military Academy, West Point, NY, are commended for their work, *Measuring Information Gain in Tactical Operations*. Their research is an amalgam of theory, live and simulation experimentation, and operational analysis. Starting from a set of plausible assumptions about the way information gain measures should behave, their research shows that the information gain measure must involve a decrease in *entropy* from earlier information. Experiments were conducted at the Military Academy by relating the level of information possessed by combat commanders with the level of success the commanders achieved in simulated battles. An information gain measure of effectiveness was developed for Janus model analyses. A set of interesting observations were developed during their analysis. Two example observations are: 1. information gained in finding a target is independent of the enemy's force size, and, 2. while information gain for a given target will usually be positive over time as reconnaissance is conducted, there are cases in which there will be increases in uncertainty with additional reconnaissance. For this creative and classical operations research Professor Donald R. Barr and Major E. Todd Sherrill have been selected to receive the 1996 Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis.

Special Award

On rare occasions, the Deputy Under Secretary of the Army for Operations Research identifies operations analyses that deserve a special Payne Award. This year for the second time in the history of the award, the DUSA(OR) has chosen the collaborative *Anti-Armor Requirements and Resource Analysis* to be honored by a Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis. Seven Army agencies and 69 analysts participated in the ground-breaking cooperative work. The agencies are: the US Army TRADOC Analysis Centers, White Sands Missile Range and Operations Analysis Center; the US Army TRADOC Offices of the Deputy Chiefs of Staff for Intelligence and Combat Developments; the US Army Concepts Analysis Agency, the US Army Materiel Systems Analysis Activity; and the US Army Military Traffic Management Command-Transportation Engineering Agency. MG James J. Cravens, Jr. said, in reference to the work being honored: "Implementing new approaches and methodologies to complete the analysis of antiarmor requirements for the future Army, this effort...should be recognized as the first analytically sound achievement that links system effectiveness, combat effectiveness, cost, and affordability in one study. [These agencies] set the standard for future analysis of systems and munitions requirements and established the realistic base of analytical information that Army leadership can use in development of current and future POM decisions." The Army agencies and analysts that participated in the analysis are heartily commended for their foresight and actions during this stressful period where collaborative, joint and combined analyses are just beginning to be recognized as critical to our national security. For this significant contribution to the US Army, the men and women of the seven agencies have been selected to receive a special 1996 Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis.